Autonomous Quadcopters Performing a Friendly Dogfight

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Drone
Defense

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Abstract

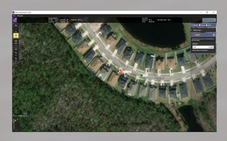
Modern drone applications extend from commercial to military and law enforcement use. Having autonomous quadcopters perform friendly dogfight demonstrates a platform that can be used in the field of protection and defense. This research aims to proof the concept of an autonomous quadcopter engaging another autonomous quadcopter as when being recognized in its field of view. Each quadcopter is built and configure to utilize an onboard computer that performs visual processing using an onboard depth perception camera. The computer communicates serially with an onboard autopilot to control the movement of the quadcopter. These quadcopters are equipped with a telemetry radio to establish communication with a designated ground station. The impact of this research project is the supplemental aid to military missions where a scan for threats in a given area is desired, the protection of restricted areas such as national parks, or restricted air space where unauthorized unmanned vehicles need interception. The quadcopter performs a follow function after acquiring positive identification of the other targeted quadcopter

Vision

- Object detection uses a neural network to create a cascade used by OpenCV
- Cascade creation used 14,000 negative and 38,000 positive sample images
- Cascade classifier type is HAAR with 10 stages, total classifier training time 10+ days
- Object detection provides a Cartesian coordinate system that is utilized for quadcopter center location

User Interface

- Front-end user interacts with the system using a designated ground control station
- Developer can interact with the onboard computer by directly logging in or establishing a remote connection
- This project used QGroundControl for the ground station and established a private network for remote connections



Software

- System uses Python 2.7.3 for the backend algorithms
  - Utilizes multiprocessing
  - Stablishes serial communication at 57600 Baud rate
- Communication with the autopilot is done via the Dronekit and Pymavlink API
  - Direct communication using MavLink Protocol
- Vision processing is performed using OpenCV and Intel RealSense API

Hardware Components

- S500 quadcopter frame
- 920Kv brushless motors with 30A ESC/5V BEC
- 10 inch propellers with 4.5 pitch angle
- 4 cell Lithium-Ion Polymer battery
- Pixhawk 4 advanced autopilot with GPS module
- 915MHz transceiver telemetry radio
- 2.4GHz RC transmitter with DSMX receiver
- Raspberry Pi 3 B+ onboard computer
- Intel RealSense D435i depth perception camera